Claims

[c1] 1. A semiconductor optical amplifier comprising:
an active layer containing quantum structures of any of quantum dots, quantum wires and quantum dashes, the active layer amplifying light propagating therein while current is injected therein;
electrodes provided for a plurality of sections of the active layer sectionalized along a light propagation direction, the electrodes being able to inject different currents into the sections; and
a power supply for supplying current to the electrodes in such a manner that a first current density is set to at least one section of the active layer and a second current density is set to at least another section, the first current density being lower than a current density at a cross point and the second current density being higher than the current density at the cross point, the cross point being a cross point between gain coefficient curves at least two different transition wavelengths of the quantum structures, the curves being drawn in a graph showing a relation between a density of current injected into the active layer and a gain coefficient of the active layer.

[c2] 2. The semiconductor optical amplifier according to claim 1, wherein at least two sections are disposed to which current is supplied at the first current density, at least two sections are disposed to which current is supplied at the second current density, and one of the two sections to which current is supplied at the second current density is disposed between the two sections to which current is supplied at the first current density.

[c3] 3. A semiconductor optical amplifier comprising:
an active layer containing a quantum structure of any of quantum dots, quantum wires and quantum dashes, the active layer amplifying light propagating therein while current is injected therein;
electrodes provided for a plurality of sections of the active layer sectionalized along a light propagation direction, each section belonging to a group selected from at least two groups, and the electrodes injecting different currents into the sections; and
a power supply for supplying current to the electrodes in such a manner that current is supplied at a same current density to the sections belonging to the same group and current is supplied at different current densities to the sections belonging to different groups.

[c4] 4. The semiconductor optical amplifier according to claim 3, wherein between two sections belonging to the

same group, one section per each of all the groups different from the aforementioned same group is disposed.

[c5] 5. The semiconductor optical amplifier according to claim 3, wherein two groups are provided and a section belonging to one group and a section belonging to the other group are alternately disposed.

[c6] 6. The semiconductor optical amplifier according to claim 3, wherein the power supply supplies current to the electrodes in such a manner that a first current density is set to each section belonging to at least one group and a second current density is set to each section belonging to at least another group, the first current density being lower than a current density at a cross point and the second current density being higher than the current density at the cross point, the cross point being a cross point between gain coefficient curves at least two different transition wavelengths of the quantum structure, the curves being drawn in a graph showing a relation between a density of current injected into the active layer and a gain coefficient of the active layer.

[c7] 7. The semiconductor optical amplifier according to claim 3, wherein a size of each of the quantum structures changes along the light propagation direction.

[c8] 8. A light amplification method comprising the steps of:
(a) injecting current into a first region of an active layer containing quantum structures made of at least ones of quantum dots, quantum wires and quantum dashes, at a current density satisfying that a gain coefficient of the quantum structures at the longest transition wavelength of the quantum structures becomes larger than a gain coefficient at the second longest transition wavelength, and injecting current into a second region different from the first region at a current density satisfying that the gain coefficient of the quantum structures at the longest transition wavelength becomes smaller than the gain coefficient at the second longest transition wavelength; and
(b) amplifying a laser beam introduced into the active layer while the current is injected into the active layer.

[c9] 9. The light amplification method according to claim 8, wherein:
in said step (a), injecting current into at least one third region different from the first region at a current density same as the current density injected into the first region, and injecting current into at least one fourth region different from the second region at a current density same as the current density injected into the second region; and
in said step (b), amplifying the laser beam also in the

third and fourth regions.

[c10] 10. A semiconductor optical amplifier comprising:
an active layer containing quantum structures of any of quantum dots, quantum wires and quantum dashes, a size of each of the quantum structures changing along a light propagation direction, and the active layer amplifying light propagating therein while current is injected therein;
an electrode for injecting current into the active layer; and
a power supply for supplying current to the electrode.